JOURNAL
OF THE
WASHINGTON ACADEMY OF SCIENCES

VOL. 17 NOVEMBER 19, 1927 No. 19

GEOPHYSICS.—*A machine for measuring the depths of deep wells.*[1]

C. E. VAN ORSTRAND, U. S. Geological Survey.

The accurate and efficient measurement of the depths of deep wells is a problem of fundamental importance in the fields of science and engineering. Unfortunately, however, but little has been done to place the solution of this important problem on a strictly scientific basis—the methods of a quarter of a century ago, although recognized as extremely awkward and for the most part incorrect, are still in use.

The necessity of having a simple and accurate method of measuring the great depths to which thermometers are lowered into deep wells while making temperature tests has led me to attempt the development of apparatus which meets the fundamental requirements of simplicity and accuracy. The investigation to date has resulted in the apparatus shown in Figures 2 and 3. Incidentally, this apparatus may provide a simple means of obtaining the depths of geological formations, thus providing the geologist with accurate data on which to base his correlations.

It is not necessary to describe here other depth recording devices. They are quite generally of the type that may be called rigid in contradistinction to the type illustrated in Figures 2 and 3, in which it will be seen at once that flexibility is a predominant characteristic.

The measuring parts of the machine shown in Figures 2 and 3 consist of two flat faced metal wheels each with $2\frac{1}{8}$ inch face and 24 inch circumference. A revolution counter geared to each wheel records the depth in feet. One counter only is shown in the illustrations. Two small pulleys, $2\frac{1}{2}$ inches by $2\frac{1}{2}$ inches, attached to a triangular frame serve to keep the cable centered with respect to the two

[1] Published by permission of the Director, U. S. Geological Survey. Received October 15, 1927.

measuring wheels. By spreading the triangle at the base, the opening between the pulleys can be adjusted to a cable of any diameter while adjustment to center is easily made by sliding the triangular frame on the large base frame. The upper part of the base frame measures approximately 12 inches by 24 inches, thus permitting bailers of 6 or 8 inches diameter to pass through the center of the machine when the steel bars carrying the wheels and pulleys have been disconnected and spread apart by rotation outwards about their points of support. The steel tubes shown on the sides of the steel frame for the insertion of legs are not always needed—it is generally more satisfactory to mount the ends of the frame on 2 inch boards which in turn are tacked lightly to the floor of the derrick. Two spiral springs assist in keeping the measuring wheels in contact with the cable, and at the same time

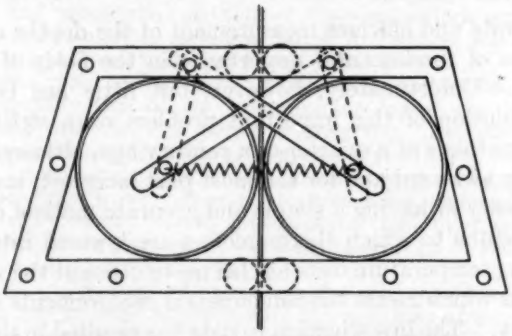

Figure 1.—Proposed arrangement of measuring wheels and guiding pulleys.

they permit a cable of varying diameter to pass between the wheels without interrupting the operation of the machine.

The apparatus described here is intended primarily for use while lowering the cable into the well, but, since the cable runs more uniformly while being removed from the well, it may be advisable to suspend the measuring parts as shown in Figure 1. Two methods of arranging the bars, represented respectively by the heavy and the dotted lines, are shown in the figure. A steel casting which permits of placing the measuring wheels above or below the plane of the casting may be preferable to the steel frame. The casting has the advantage of tending to keep the measuring wheels more nearly in the same vertical plane.

In operation the machine is centered with respect to the cable in its normal position while being lowered into or removed from the well. Ordinarily, this position is not in the center of the well. A level placed

first longitudinally in contact with the upper tangent points of the measuring wheels and then transversely across the steel frame is used in making the final adjustment. Agreement of the records of the two counters at the end of the run is an exceedingly severe, but extremely useful check on the measurement.

The chief sources of error are longitudinal and transverse vibrations of the cable. Longitudinal vibrations are caused by the slipping of the coils of the cable on the reel, whereas transverse vibrations are

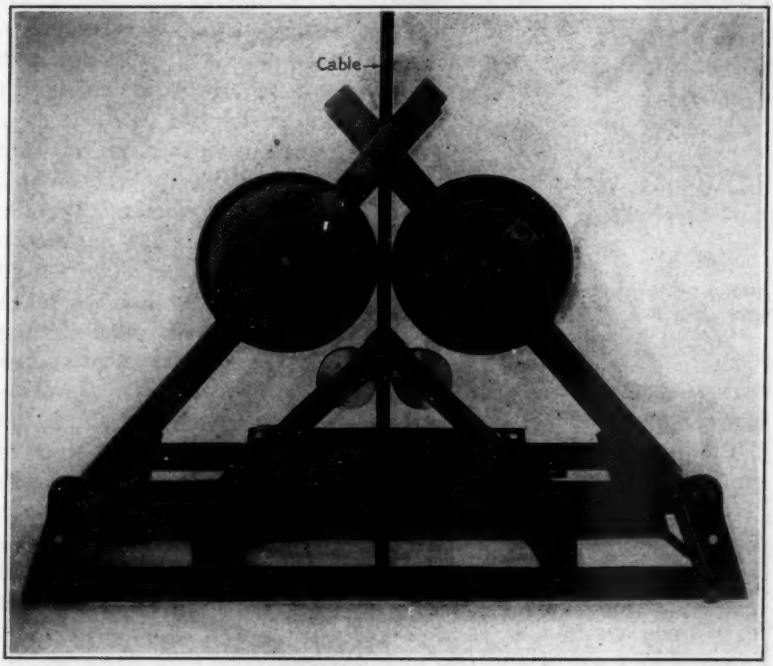

Figure 2.—Side view of depth recorder.

the result of periodic impulses transmitted to the cable from the engine or other parts of the oil well machinery. Adhesion of the cable to the wall of the well and release from the same produce a combination of longitudinal and transverse vibrations that may be quite serious. Any one of the errors just described may be so serious as to prevent a machine from making an accurate record, but, for velocities of the cable not exceeding 200 feet per minute, these errors are not likely to be serious, and they can generally be eliminated by changing slightly the

speed of the engine, or by adopting some other simple method of procedure.

In order to consider the possible discrepancies in the measurements resulting from sliding friction, let it be assumed that a well is measured first with a frictionless line and weight (W), the depths being recorded at the top of the well by means of a wheel which accurately records

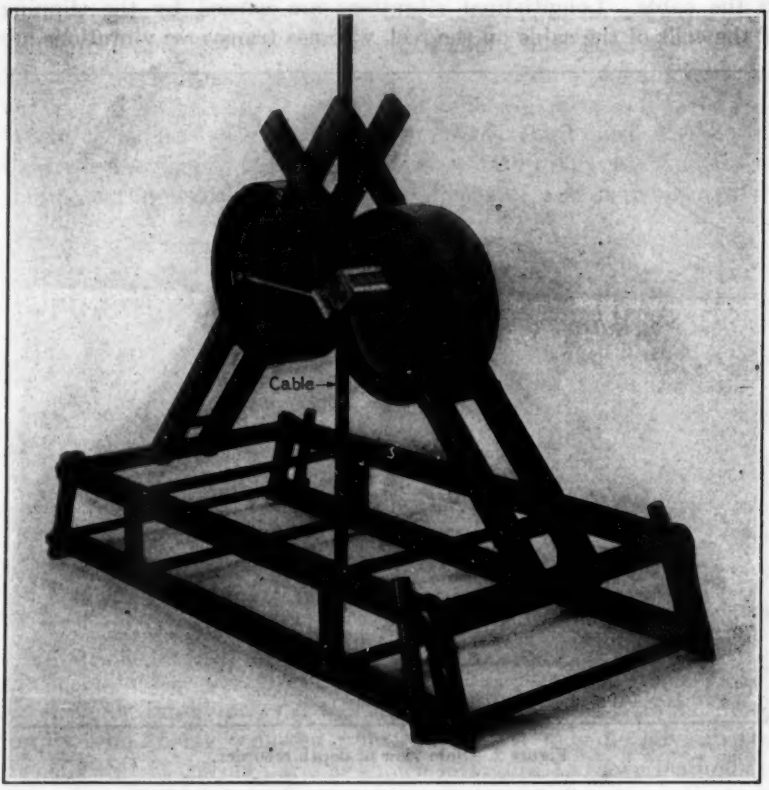

Figure 3.—Side and end view of depth-recorder without guiding pulley.

the length of line passing the tangent point of the wheel as shown in the sketch, Figure 4. The depths recorded by the wheel are identical whether the weight is lowered into or removed from the well. Assuming Hooke's Law, the true depth can be calculated from the observed depth on the basis that the tension in the line is due to a load equal to the weight (W) + ½ (weight of the line).

Assume a second case in which the frictional effects resulting from the movement of the line and weight (W) are identical in magnitude, but opposite in sign according as the cable is being raised or lowered. In this case the mean of the two observed depths corrected as before for a total load equal to the weight (W) + ½ (weight of the line) leads to a correct result.

In all practical applications, however, it is obvious that the ideal conditions just described are not fulfilled—the probability that the frictional resistances will exactly compensate each other when the cable is moved in opposite directions is practically zero. Hence, it follows that the true depth of a well can not in general be determined from the mean of two observations made with a perfect recording machine at the top of the well. In measurements of one direction only, such as the well known method of "stringing over the derrick," the error is increased as frictional effects are not compensated. Frictional effects resulting from the motion of the line do not appear in measurements made with a metal tape, but the true depth of a well can not be determined from an observation of this kind for the reason that the variation in the tension of the tape from the top to the bottom of the well is unknown. The adhesive force between the tape and the wall of the well is usually very intense. It is probably caused chiefly by atmospheric pressure acting in conjunction with a film of moisture that occupies the space between the surface of the tape and that portion of the inner surface of the well with which it is in contact.

Figure 4.—Showing cable and measuring wheel.

The preceding theoretical considerations show that identity of measurements with a perfect recording machine at the top of a well is not to be expected. I have no information as to the magnitude of the error when the oil well cable is used as a measuring line. With a number 20 polished steel piano wire carrying a load of 7 pounds (3.2 kilograms), I have found differences of the order of magnitude of 0.5 foot per 1000 feet of measured length.[2] An exception to these observations is that measurements of depths of something like 1000 feet are frequently identical regardless of the direction of motion of the

[2] *Apparatus for the measurement of temperatures in deep wells by means of maximum thermometers.* Econ. Geol. **19**: 247. April—May, 1924.

line, the wells in these instances being so nearly vertical over the first 1000 feet that the line does not come in contact with the wall of the casing.

In a recent test near Johnstown, Pennsylvania, one counter of the depth recorder registered 6719 feet, the other 6721 feet; and in a test made a few years ago with a single measuring wheel[3] in deep well No. 1842 of The People's Natural Gas Company, located near Ligonier, Pennsylvania, the recorded depth was 7697 feet. This result compared favorably with the value 7705 feet obtained by The People's Natural Gas Company using the method of "stringing over the derrick." Other partial tests which have been made from time to time while lowering thermometers to different depths showed that discrepancies of 1 foot per 1000 feet of measured length are to be regarded as rather extreme. It has been impossible to make accurate comparisons, as an error of possibly 0.5 foot may have been made in reading the revolution counters.[4]

To test a depth recorder accurately, it would be necessary to measure off on the cable with a metal tape under given tension a given length as the cable passes in a vertical line from the top of the derrick to the floor. The total length of cable should be limited to a point such that frictional effects in the casing do not appear. I have not been able to make this test, but, judging from the agreement of the readings of the counters and the duplication of measurements to the same point on the cable, I am of the opinion that measurements of rather exceptional accuracy can be made with a machine embodying the fundamental requirements of stability, flexibility, and symmetrical distribution of load on the cable as contained in the apparatus shown in Figures 1, 2, and 3. An obvious advantage in the arrangement of parts shown in the figures is that the measuring wheels tend always to fall towards the cable without causing it to be displaced laterally from its normal position. The apparatus shown in Figures 2 and 3 is convenient for use on field trips when one desires occasionally to test a well in which the casing extends 2 or 3 feet above the level of the derrick floor. The more compact form shown in Figure 1 is probably more convenient for use while drilling or conducting other deep well operations. The supporting bars could be attached also to the lower part of the steel frame so as to make an arrangement of measuring wheels like that shown in the upper part of Figures 2 and 3.

[3] See paper cited in footnote 2 for description of machine.

[4] Reset revolution counter. M34. Four figures. Veeder Mfg. Co., Hartford, Conn.

Finally, identity of measurements independent of the direction of motion of the measuring line is an essential requirement of a perfect recording instrument when operating under conditions such that frictional forces in the well do not make their appearance. In practice, the mean of two readings obtained by running the cable in opposite directions appears to be the closest approximation that can be made to the true depth of a well.

I am especially indebted to Mr. John B. Tonkin, Vice President of The People's Natural Gas Company, Pittsburgh, Pa., and Mr. Kern Dodge of Philadelphia, Pa., for their generous coöperation in making the tests respectively at Ligonier and Johnstown, Pennsylvania. Mr. Dodge assisted personally in making the observations at Johnstown. The Ligonier well reached a total depth of 7756 feet making it, at the time of its completion, the deepest well in the world. This record of exceptional depth has since been surpassed by the deep well of the Chanslor-Canfield Midway Oil Company, Olinda 96, near Brea, California, the total depth as reported a few months ago being 8046 feet.

PALEONTOLOGY.—*Notes on foraminifera in the collection of Ehrenberg.*[1] J. A. CUSHMAN, Sharon, Massachusetts.

Between 1838 and 1872 Ehrenberg published many new generic names for fossil and recent foraminifera. Of these very few are accepted at present and indeed of many not enough has been known to determine their status in the accepted scheme of classification. In order to place these uncertain genera and to learn more about the species which should be considered genotypes of Ehrenberg's genera, I undertook a study of part of the original collection in Berlin. My thanks are due to Professor Pompecki, Rector of the University, for permission to study the collection and to Dr. Dietrich for his many courtesies.

As the collection has apparently not been consulted for a great many years, something of its general character may be noted. Ehrenberg's preparations, which include diatoms and foraminifera particularly, are chiefly balsam mounts. These are for the most part still in excellent condition, the balsam slightly yellowed with age, as is to be expected, but very clear indeed and showing no signs of deterioration, and the specimens in no wise impaired for study. The collection is contained

[1] Received October 6, 1927.

in a large number of book-like holders with the volume numbers and the general localities marked on the backs. In each volume are usually twelve double card-board trays, hinged at the back and numbered and named on the top. These trays, when lifted out and carefully opened, display the mounts themselves, made of small cover-glasses with balsam between and fastened to strips of mica, five mounts to each strip. The ends of the strip are inserted in slits in a large sheet which fits into the tray and often bears on the lower part a list of the included species. On the surface of the cover-glasses are very small rings of various colors, each ring containing figured or named specimens. With the collection is a catalogue, arranged evidently by Ehrenberg, giving the genera, and under each genus in alphabetical order the species, and for each species the book and tray in which it is to be found.

A collection of Ehrenberg's original drawings, beautifully done in pencil, ink, and water color, is also preserved. There are more than twenty-five hundred sheets of these drawings, many sheets with numerous figures. The drawings are accurate and much better executed than are the figures on the published plates. Each individual figure bears a notation in ink or pencil referring to the volume, tray, strip, slide, and colored ring, so that the original specimen may be very quickly found. At first the system would seem to be a complex one, but it is in reality very workable, as the catalogue gives under each species a column referring to the original sheet of drawings on which the species appears.

The specimens may be studied both by transmitted light, the method by which Ehrenberg largely worked, and by reflected light, by which it is possible to get a good idea of the surface.

In the following pages a few notes are given on certain species of especial interest in settling questions of nomenclature which relate to American species.

The genus *Grammostomum* of Ehrenberg has as its first figured species *G. tenue* Ehrenberg (Abhandl. K. Akad. Wiss. Berlin, 1841, p. 426, pl. III, vii, f. 45). This then is the species which is the genotype. A study of this figured specimen shows it to be a *Bolivina*, and *Grammostomum* Ehrenberg, 1841, becomes a synonym of *Bolivina* d'Orbigny, 1839. The other two species named in 1841 were not figured by Ehrenberg, and *Grammostomum tenue* Ehrenberg must stand as the only choice. Later many different things were referred to *Grammostomum* by Ehrenberg.

Spirillina Ehrenberg, 1841, has as its genotype *S. vivipara* Ehrenberg, a recent species with the type from Vera Cruz. An examination of the original specimen shows that it is as figured by Ehrenberg and as understood by later authors—with a proloculum and long planispirally coiled second chamber, the wall calcareous and perforate. The species name is derived from the occurrence of two young specimens in the parent test, a feature which shows excellently in the mounted specimen.

Allotheca Ehrenberg, 1841, is a monotypic genus, the genotype being *A. megathyra* Ehrenberg (Abhandl. K. Akad. Wiss. Berlin, 1841, p. 426, pl. III, vii, f. 49). Sherborn gives a note in his *Index*, "= Planorb. farcata, Young; with coarse pores." A study of the original figured specimen seems to place it under *Discorbis* Lamarck, 1804, and therefore *Allotheca* Ehrenberg should be considered a synonym of *Discorbis*.

Aristerospira Ehrenberg, 1858, had five species which were later figured (1873). In the order of the figures on the plate (Abhandl. K. Akad. Wiss. Berlin, 1872 (1873), pl. XI) these are *Aristerospira isoderma* Ehrenberg, *A. laevigata*, Ehrenberg, *A. globularia* Ehrenberg, *A. alloderma* Ehrenberg, and *A. platypora* Ehrenberg. I examined the types of all of these species, and found that they are to be referred to *Discorbis* Lamarck, of which *Aristerospira* becomes a synonym. The genotype of *Aristerospira* is *A. isoderma* Ehrenberg, selected because it is the first of the original species figured.

Pylodexia Ehrenberg, 1858, had two species at the time of description, of which *P. tetratrias* Ehrenberg was later figured and is therefore chosen as the genotype. A study of the types of this species shows it to be a *Globigerina*. One of the specimens, evidently microspheric, shows the "*Pulvinulina*"-like young as also figured by Rhumbler and others. On the original sheet of drawings this was marked in ink "*Globigerina*," evidently by Ehrenberg. *Pylodexia* Ehrenberg is therefore a synonym of *Globigerina* d'Orbigny.

Strophoconus Ehrenberg, 1843, had several species, the first of which figured, *S. auricula* Ehrenberg (*Mikrogeologie*, 1854, pl. XX, ii, f. 2), should be designated as the genotype. It is a young *Virgulina*, as noted by Sherborn.

Aspidospira Ehrenberg, 1844, had no species figured until the illustration in 1854 of *A. saxipara* Ehrenberg (*Mikrogeologie*, 1854, pl. XXXII, ii, f. 38). This is the common *Anomalina* of the Cretaceous of America, not the same as "*Planulina ariminensis*" as given by

Sherborn in his *Index*. By reflected light the type specimen figured by Ehrenberg is seen to have a raised suture about the middle part. As drawn by Ehrenberg the earlier chambers are not correct and the suture really represents the raised area about the center. The specimen is too thick and opaque to show the inner chambers pictured in the figure.

Porospira Ehrenberg, 1844, had several species, but the first of these figured, *P. comes* Ehrenberg (*Mikrogeologie*, 1854, pl. XXI, f. 93), is taken as the genotype. An examination of the type shows it to be an *Anomalina*, and *Porospira* becomes a synonym of that genus.

Proroporus Ehrenberg, 1844, is really a monotypic genus, as it had but a single species, *P. lingua*, figured later (*Mikrogeologie*, 1854, pl. XXI, f. 83). The type of this genotype species, examined in Berlin, shows the aperture to extend to the inner margin of the last-formed chamber and the species is therefore a true *Bolivina*. The published figure shows a costate surface but neither the type specimen nor Ehrenberg's original drawing show this. *Proroporus* Ehrenberg must therefore be placed as an exact synonym of *Bolivina* and can not be used for those species which tend to become uniserial (See *Loxostomum*).

Heterohelix Ehrenberg, 1843, was later changed by Ehrenberg to *Spiroplecta* but *Heterohelix* must stand as the generic name. The genotype is *H. americana* Ehrenberg. The slide is marked "Kreide von obern Mississippi in Amerika." The young shell is planispiral, the test clearly calcareous and not arenaceous. It is a species of the American Cretaceous.

Cenchridium Ehrenberg, 1845, had as the only species *C. sphaerula* Ehrenberg. The original specimen and original unpublished drawing show it to be an *Entosolenia*.

Heterostomum Ehrenberg, 1854, has as its genotype *H. cyclostomum* Ehrenberg, the first figured species. This is a very poor specimen from the Chalk of Gravesend, smooth, and possibly a *Guembelina* but not certainly.

Pleurites Ehrenberg, 1854, has as the first species figured *P. cretae* Ehrenberg (*Mikrogeologie*, 1854, pl. XXVII, f. 32), which may be taken as the genotype. The type specimen has a smooth surface with the aperture and triserial form of *Bulimina*. *Pleurites* should be placed under that genus as a synonym.

Loxostomum Ehrenberg, 1854, has as the species first figured *L. subrostratum* Ehrenberg (*Mikrogeologie*, 1854, pl. XXVII, f. 19), which is chosen as the genotype. The type specimen in the Ehrenberg

collection, from Meudon, is biserial throughout, with the aperture in the early portion as in *Bolivina*, later above the base of the inner margin and tending to become uniserial. The test is calcareous and not as given in Sherborn's *Index*, "Bigenerine *Text. agglutinans.*" The name *Loxostomum* should therefore be used for those forms, derived from *Bolivina*, in which the aperture becomes terminal away from the inner margin. It will take the place of *Proroporus* Ehrenberg, as at present used, which, as already noted, is an exact synonym of *Bolivina*.

Notes were made on many other genera of Ehrenberg and on the American species figured by him in Plate XXXII of the *Mikrogeologie* but these will be left for a later paper.

BOTANY.—*Mosses from Ecuador, collected in 1918 by Dr. J. N Rose.*[1] R. S. WILLIAMS, New York Botanical Garden. (Communicated by WILLIAM R. MAXON.)

This lot of 49 species of mosses, obtained incidentally while making general collections of phanerogams and ferns in Ecuador, is of course but a fraction of the moss flora that may be found in any favorable tropical region where the mountains reach heights far above snow-line. As will be seen, the greater number of species in the list are from the town of Huigra and vicinity, at about 9,000 feet elevation. Mosses often flourish in the tropics, however, from a few hundred feet above sea level to at least 16,000 or 17,000 feet, or nearly to the line of perpetual snow, and a collector able to give all his time to this one class of plants in a region where, from the same starting point, he might often make easy walking trips in a day to orange groves in one direction or to perpetual snows in the other, would soon find himself in possession of a wonderful variety of species.

In this list, oddly enough, the 49 species are distributed among no fewer than 37 genera. The genus *Campylopus* is not represented at all, although it is widely distributed in South America, some 21 species, for example, being already known from the neighboring country of Venezuela. *Fissidens*, here represented by a single collection, has 16 or more species in Venezuela, and *Macromitrium* about the same number.

The collection numbers cited in parentheses below are those given by Dr. Rose. He was assisted by his son, George Rose, and A. Pachano.

[1] Received October 11, 1927.

FISSIDENS CRISPUS Mont.
Vicinity of Huigra, 9,000 ft., Sept. 4 (23650).
PLEUROCHAETE LUTEOLA (Besch.) Thér.
Trichostomum luteolum Besch. Prod. Bryol. Mex. 34. 1871.
Vicinity of Cuenca, Sept. 17–24 (24038).
LEPTODONTIUM ACUTIFOLIUM Mitt.
Cañar, Sept. 16 (23661).
LEPTODONTIUM LUTEUM (Tayl.) Hampe.
Vicinity of Portovelo, Oct. 5–15 (24039).
LEPTODONTIUM SULPHUREUM (C. M.) Mitt.
Vicinity of Portovelo, Oct. 6–15 (24040).
TORTULA DECOLORANS (Hampe) Mitt.
Tixan, 9,200 ft., Aug. 23 (23635).
TORTULA PICHINCHENSIS (Tayl.) Mitt.
Vicinity of Zaragura, Sept. 27 (23675).
TORTULA REPLICATA (Tayl.) Mitt.
Vicinity of Huigra, Sept. 7 (23639, 23653, 23655). Vicinity of Cuenca, Sept. 17–24 (23670).
RHACOMITRIUM CRISPIPILUM (Tayl.) Jaeg.
Vicinity of Loja, Sept. 29–Oct. 3 (24041).
ORTHOTRICHUM PUNGENS Mitt.
Vicinity of Cuenca, Sept. 17–24 (24042).

Macromitrium huigrense, sp. nov.

Pseudoautoicous. Male plants minute, scarcely 0.5 mm. high, the flower composed of about 8 ovate, acute to rather obtuse, very mamillose-celled leaves, crenulate on the border and partly costate, inclosing a few small antheridia. Fertile plants with creeping stems and stout, erect branches mostly 1–2 cm. high; branch leaves crowded, 4–5.5 mm. long, appressed in the lower part when dry, the points spreading–flexuous, more or less twisted and sometimes undulate, long-lanceolate from a slightly narrowed base, plicate or keeled along the costa, the margins slightly crenulate along the middle, the apiculate point serrulate; costa slender, about 40μ wide near the base, nearly or quite percurrent; cells of upper part of leaf mamillose on both sides, the median scarcely elongate, about 6μ wide by 6–9μ long, in rows and somewhat furrowed between; basal cells much longer, with thickened and pitted walls often bearing prominent, scattered papillae over the surface; perichaetial leaves much like those of the branches but broader and smooth in the basal part; seta 14–18 mm. long, very rough throughout and twisted in the upper part when dry; capsule ovate, 8-ribbed when dry, about 2 mm. long without lid, with stomata in three rows at its base, the conical lid with erect beak a little over 1 mm. long; preperistome of several rows of rather large, pale cells; peristome double, the outer of blunt teeth, at first united nearly to their apex, the outer surface finely punctate; inner peristome paler, about the height of the outer, the basal membrane extending about one-third up, the segments split into somewhat lanceolate, often irregular and curving points; spores rough, 35–40μ in diameter; calyptra deeply fissured about the base and bearing prominent but rather scattered hairs over its surface.

Vicinity of Huigra, Ecuador, at 9,500 ft. elevation, Sept. 3, 1918, *J. N. & George Rose* 23645, type.

This apparently undescribed species has much the appearance of *M.*

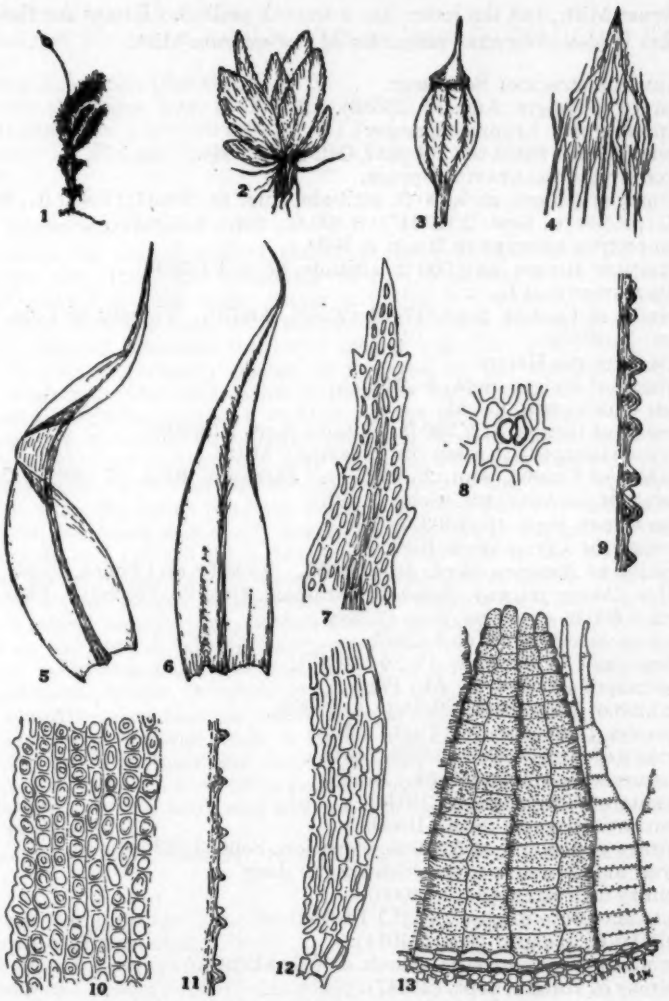

Figure A. *Macromitrium huigrense*, sp. nov.

1. Fruiting plant, about natural size.
2. Male plant, × 40.
3. Capsule, × 8.
4. Calyptra, × 8.
5. Stem leaf, × 8.
6. Perichaetial leaf, × 8.
7. Apex of stem leaf, × 200.
8. Stoma, × 180.
9. Part of pedicel showing papillae, × 200.
10. Median cells of stem leaf, × 200.
11. Surface near base of leaf showing papillae, × 200.
12. Leaf margin at base, × 200.
13. Part of peristome, × 150.

proliferum Mitt., but the latter has a smooth pedicel. Except for the hairy calyptra it also somewhat resembles *M. subscabrum* Mitt.

FUNARIA CALVESCENS Schwaegr.
Vicinity of Huigra, Aug. 16 (23636).
MIELICHHOFERIA LINDIGII Hampe.
Along railway, Sassa to Cotopaxi, Oct. 26 (23684).
ACIDODONTIUM EXALTATUM Spruce.
Vicinity of Huigra, at 6,000 ft. altitude, Aug. 18 (23634); 5,800 ft., Sept. 3 (23641); 8,500 ft., Sept. 2 (23647); 8,800 ft., Sept. 4 (23649).
ACIDODONTIUM SEMINERVE Hook. & Wils.
Vicinity of Huigra, at 8,000 ft. altitude, Sept. 4 (23646).
BRYUM ARGENTEUM L.
Vicinity of Cuenca, Sept. 17–24 (23666, 23673). Vicinity of Loja, Sept. 29–Oct. 3 (23679).
BRYUM CRUGERI Hampe.
Vicinity of Huigra, Sept. 6 (23652).
MNIUM LIGULATUM C. M.
Vicinity of Huigra, at 8,700 ft. altitude, Sept. 7 (23648).
POLYTRICHADELPHUS ARISTATUS (Hampe) Mitt.
Vicinity of Cumbe, Sept. 25 (23674). Zaragura, Sept. 27 (23677, 24044).
POGONATUM POLYCARPUM (Sch.) Broth.
Near Cañar, Sept. 16 (24037).
POLYTRICHUM ANTILLARUM Rich.
Vicinity of Azognes, Sept. 16 (23663). Vicinity of Cuenca, Sept. 17–24 (23667). Along railway, Sasso to Cotopaxi, Oct. 26 (23683). Vicinity of Huigra, 5,500 ft. elevation, Aug. (23638).
HEDWIGIA ALBICANS (Web.) Lindb.
Vicinity of Cuenca, Sept. 17–24 (24045).
RHACOCARPUS EXCISUS (C. M.) Par.
Vicinity of Loja, Sept. 29–Oct. 3 (24002).
PRIONODON LUTEOVIRENS (Tayl.) Mitt.
Vicinity of Huigra, Oct. (24008, 24013).
SQUAMIDIUM NIGRICANS (Hook.) Broth.
Vicinity of Huigra, Sept. (24046).
SQUAMIDIUM NITIDUM (Sull.) Broth.
Vicinity of Huigra, at 5,200 ft. elevation, Sept. 3 (23640).
PILOTRICHELLA HEXASTICHA (Schwaegr.) Jaeg.
Vicinity of Huigra, Oct. (24000).
PAPILLARIA IMPONDEROSA (Tayl.) Broth.
Vicinity of Huigra, Oct. (24011).
FLORIBUNDARIA TENUISSIMA (Hook. & Wils.) Broth.
Vicinity of Huigra, Sept. (24047).
LINDIGIA ACICULATA (Tayl.) Jaeg.
Vicinity of Ayapamba, Oct. 15 (24048).
METEORIOPSIS PATULA (Sw.) Broth.
Vicinity of Cuenca, Sept. 17–24 (24050). Vicinity of Huigra, Oct. (24049).
NECKERA JAMESONI Tayl.
Vicinity of Huigra, Aug. (23656); Sept. 11 (24051); Oct. (24001).
POROTRICHUM KORTHALSIANUM (Dz. & Mb.) Mitt.
Vicinity of Huigra, Oct. (24004).
POROTRICHUM LONGIROSTRUM (Hook.) Mitt.
Vicinity of Huigra, Oct. (24003).

POROTRICHUM STRIATUM Mitt.
Vicinity of Huigra, at 9,000 ft. altitude, Sept. 7 (23651); Oct. (24006, 24014).
ENTODON BEYRICHII (Schwaegr.) C. M.
Vicinity of Huigra, Aug. 16 (23631).
ERYTHRODONTIUM LONGISETUM (Hook.) Par.
Vicinity of Huigra, Sept. (23658.) Vicinity of Cuenca, Sept. 17–24 (23668).

Rozea Roseorum, sp. nov.

Autoicous, the male flowers on the stem often near the base of the pedicel, about 0.2 mm. long, and consisting of pale, ecostate, ovate, lanceolate-pointed, nearly or quite entire leaves enclosing 6–8 antheridia. Plants in rather loose, thin cushions, with procumbent, slightly branching stems and distant, irregular branches, the latter mostly less than 1 cm. long; leaves rather cymbiform, scarcely plicate or recurved on the margins, narrowly ovate, acutely pointed and entire or minutely serrulate in the upper part, with costa vanishing near or a little above the middle of leaf; stem leaves 2–3 mm. long, somewhat secund and spreading, those of the branches a little smaller, nearly erect and rather closely imbricate when dry, somewhat spreading when moist; leaf-cells smooth, elongate, except the basal, the median about 6μ wide and up to 60μ long, slightly sinuous, with rounded ends and thin walls; the basal cells nearly square or transversely elongate, extending to the costa and upward for a distance of 15–25 cells in the margin; perichaetial leaves mostly entire, broadly lanceolate, with a pale, short costa, the inner a little shorter or sometimes longer than those of the stem; seta dark red, about 15 mm. long; capsule oblong to oblong-cylindric, 1.5–2 mm. long with the conical lid, the exothecal cells very irregular, more or less elongate, with thick walls, the stomata in 1 or 2 rows at the base; annulus none; peristome double, the teeth cross-striate on the outer face below, somewhat obliquely striate near the middle and papillose above; segments of inner peristome finely papillose, from a basilar membrane nearly one-third the height of the teeth, narrowly lanceolate from a broad base, not or very slightly split along the keel, often rather irregular, mostly a little more than half the height of the teeth and without cilia; spores minutely punctate, up to 28μ in diameter.

Vicinity of Huigra, Ecuador, Sept. 12, 1918, *J. N. & George Rose* 23657, type.

CYCLODICTYON ALBICANS (Sw.) Broth.
Vicinity of Huigra, Aug. (24052).
HOOKERIOPSIS ADUNCA (Mitt.) Jaeg.
Vicinity of Cuenca, Sept. 17–24 (24053).
LEPIDOPILUM INTERMEDIUM (C. M.) Mitt.
On bamboo, vicinity of Huigra, Sept. 13 (23659).
RHACOPILUM TOMENTOSUM (Sw.) Brid.
Vicinity of Huigra, Aug. (23632); Oct. (24007).
LESKEA GRACILLIMA Tayl.
Vicinity of Cuenca, Sept. 17–24 (23669).
RAUIA PLUMARIA (Mitt.) Broth.
Vicinity of Huigra, Sept. (24054).
THUIDIUM BRASILIENSE Mitt.
Vicinity of Portovelo, Oct. 6–15 (24055).

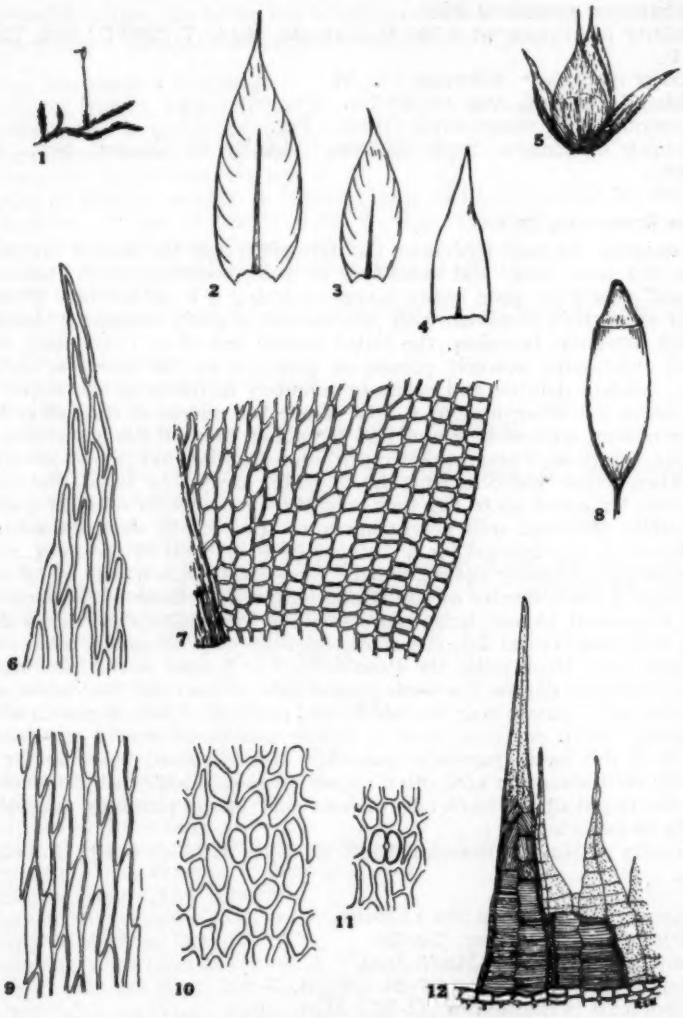

Figure B. *Rozea Roseorum*, sp. nov.

1. Plant, about natural size.
2, 3. Upper and lower stem leaves, × 12.
4. Inner perichaetial leaf, × 12.
5. Male flower, × 12.
6. Apex of stem leaf, × 300.
7. Part of leaf base, × 200.
8. Capsule, × 18.
9. Median cells of leaf, × 300.
10. Median cells of capsule, × 200.
11. Stoma, × 200.
12. Part of peristome, × 150.

THUIDIUM CYLINDRACEUM Mitt.
Vicinity of Huigra, Sept. 7 (24057). Without special locality or date (24056).
THUIDIUM PERUVIANUM Mitt.
Vicinity of Portovelo, Oct. 6–15 (23680).
MITTENOTHAMNIUM ANDICOLA (Hook.) Card.
Vicinity of Huigra, Oct. (24012).
MITTENOTHAMNIUM REPTANS (Sw.) Card.
Vicinity of Huigra, Aug. (24058).

BOTANY.—*On a small collection of pteridophytes from the province of Kansu, China.*[1] CARL CHRISTENSEN, Botanisk Museum, Copenhagen.

Although the fern flora of the southwestern provinces of China is now comparatively well known, very few species have been recorded hitherto from certain other provinces, notably Shan-si and Kansu. From the latter large province, which lies in the northwestern corner of China proper, the National Geographic Society's Central China Expedition, under the direction of F. R. Wulsin, has brought home a small collection of ferns gathered by Mr. R. C. Ching in 1923, which Dr. William R. Maxon, Associate Curator of the U. S. National Herbarium, has sent me for identification. The collection contains barely a score of species, but is nevertheless very interesting, owing to the fact that here, so far to the north, we still find the same mixture of different regional elements that is noted in the southern provinces. As might be expected, the northern types (nine species) are in a majority; but not less than six species are of southern relationship, one or two of them (*Drynaria*, *Polypodium*) being nearly tropical; five species are common Central East Asiatic forms; and two (*Athyrium* and *Adiantum pedatum*) are common to North America and eastern Asia.

The list of species is as follows, the new species being described at the end:

WOODSIA GLABELLA R. Br.
La Chang K'ou, near Sining; alt. 3060 m.; in shaded, very moist pockets of slopes (612).
WOODSIA LANOSA Hook.
La Chang K'ou, near Sining; alt. 3000 m.; common in crevices of shaded cliffs by a stream (630).
WOODSIA MACROSPORA C. Chr. & Maxon, sp. nov.
Gargannar, south of Old Taochow; alt. 3720 m.; crevices of rocky cliff, in a gorge; rare (906).

[1] Received October 5, 1927.

CYSTOPTERIS FRAGILIS (L.) Bernh.

Lan Ze Cheon K'ou, near Sining; alt. 2650 m.; shady cliffs; not common (592).

CYSTOPTERIS KANSUANA C. Chr., sp. nov.

La Chang K'ou, near Sining; alt. 3060 m.; on densely shaded rocky cliff by a stream (631).

CYSTOPTERIS MONTANA (Lam.) Bernh.

Ta Hwa, near Pingfan; alt. 2940 m.; common, under trees (553). Near Pingfan; alt. 2610 m.; common on moist, shaded cliffs (572).

DRYOPTERIS BARBIGERA (Hook.) Kuntze.

La Chang K'ou, near Sining; alt. 2910 m.; common on shaded rocky cliffs by a stream (635).

DRYOPTERIS GIRALDII (Christ) C. Chr., sp. nov.

Hsia Mo K'ou, near Lichen; alt. 2070 m.; common under trees (382).

DRYOPTERIS LINNAEANA C. Chr., var. LONGULA Christ.

Near Pingfan; alt. 2610 m.; common under trees, or on shaded moist rocky cliffs (573).

DRYOPTERIS ROBERTIANA (Hoffm.) C. Chr.

Gargannar, south of Old Taochow; alt. 3720 m.; in forest, at the foot of rocky cliffs; common (901).

POLYSTICHUM SHENSIENSE Christ.

Ta Hwa, near Pingfan; alt. 3210 m.; under bushes, in thin shade (518). La Chang K'ou, near Sining; alt. 3060 m.; shaded base of large rock on an exposed slope (609).

POLYSTICHUM SHENSIENSE Christ, var. TENERIFRONS C. Chr.

Archuen, south of Choni; alt. 4050 m.; common, in fir forest (979).

ASPLENIUM SARELII Hook.

Vicinity of Lichen; alt. 1860 m.; on shaded rocky cliff (307).

ATHYRIUM ACROSTICHOIDES (Sw.) Diels.

Gargannar, south of Old Taochow; alt. 4050 m.; mossy floor of dense fir and spruce forest; common (907).

ADIANTUM ROBOROWSKII Maxim.

Gargannar, south of Old Taochow; alt. 3780 m.; on rocky cliff, in forest; common (902).

ADIANTUM VENUSTUM Don.

Lan Ze Cheon K'ou, near Sining; alt. 2610 m.; large dense colonies in very moist forest (587).

ADIANTUM PEDATUM L. var. GLAUCINUM Christ.

Hsia Mo K'ou, near Lichen; alt. 1950 m.; in dense forest (326).

CHEILANTHES ARGENTEA (Gmel.) Kunze.

Lan Ze Cheon K'ou, near Sining; alt. 2610 m.; on a shaded rocky cliff (597).

CRYPTOGRAMME STELLERI (Gmel.) Prantl.

La Chang K'ou, near Sining; alt. 3000 m.; moist crevices of shaded rock-slopes; common (614).

POLYPODIUM CLATHRATUM Clarke.

Near Pingfan; alt. 2610 m.; rocky crevice of shaded cliff, in moist gorge; common (571). Gargannar, south of Old Taochow; alt. 3750 m.; common on rocky cliffs in forest (903).

DRYNARIA SINICA Diels.

Moist exposed foothills, near Pingfan; alt. 2460 m.; forming dense carpet; common (481).

EQUISETUM RAMOSISSIMUM Desf.

Vicinity of Ningsia; alt. 1770 m.; common along mountain streams (204).

Woodsia macrospora C. Chr. & Maxon, sp. nov.

Rhizome suberect, stout, 2–3 cm. long, 1–1.5 cm. thick, becoming multicipital, densely clothed with thin, yellowish brown, lanceolate-subulate scales. Fronds numerous, laxly ascending, 8–15 cm. long, the stipes 2–8 cm. long, slender, dull yellowish, scantily clothed with lax linear-subulate scales, these smaller upward, extending throughout the rachis, intermixed with long and short septate hairs; blades lance-oblong, slightly or not reduced at base, obtuse at apex, 6–9 cm. long, 2–2.5 cm. broad, pinnate, terminating abruptly in a subconform pinna, thin-herbaceous, delicately flaccid-hairy throughout, with shorter hairs intermixed; pinnae 6–8 pairs below the terminal one, subequal, 10–13 mm. long, 5–8 mm. broad, nearly horizontal, alternate to subopposite, sessile, ovate-oblong, subequally truncate-cordate at base, broadly rounded at apex, crenate; veins evident, once or twice forked; sori large, uniserial, medial; sporangia with a few flaccid hairs intermixed, large, globose, with a thick annulus, the spores very large (about 60μ in diameter, nearly black, globose, in lateral view coarsely verrucose, i.e., the exosporium furnished with reticulate crests.

Gargannar, south of Old Taochow; alt. 3720 m.; crevices of rocky cliff, in gorge; rare, August 29, 1923; *R. C. Ching* 906.

In general habit somewhat resembling *Woodsia Rosthornii* Diels (*W. Delavayi* Christ), which, however, is much more hairy and has the blade narrowed gradually downward, the apex pinnatifid. Otherwise our new species seems very unlike all other members of the genus, being especially remarkable for its impari-pinnate blade, large sporangia, and large black spores. The spores of *W. Andersoni* Christ, though similar, are scarcely verrucose, and that species is otherwise very different.

Cystopteris kansuana C. Chr., sp. nov.

Rhizome short-creeping, slender, 2–4 cm. long, about 1 mm. thick, flexuous, branched, very scantily paleaceous. Fronds several, borne 2–5 mm. apart, laxly ascending, 8–16 cm. long, the stipes capillary, castaneous, nearly or quite as long as the blades, with a few thin scales at base, glabrous; blades lanceolate, long-acuminate to a subcaudate apex, 4–8 cm. long, 1.3–2 cm. broad below the middle, bipinnate, thin-herbaceous, glabrous; pinnae in 6 or 7 well-developed pairs below the pinnatifid apex, the lower ones at distances of 1–1.5 cm. apart, short-petiolulate, subopposite, 1 cm. long or less, deltoid, inequilateral at base, the costae winged; pinnules 1–3 pairs below the pinnatifid apex, the distal basal one much the largest, toothed, with the teeth cleft; veins raised beneath, pinnate in the larger segments, forked in the smaller ones, running out to the extreme sinus of the emarginations, these usually bordered by 2 unequal teeth; sori medial or inframedial; indusium ovate, entire, brown, persistent; spores immature.

La Chang K'ou, near Sining; alt. 3060 m.; on densely shaded rocky cliff, by a stream; *R. C. Ching* 631.

In several respects the present species is similar to small forms of *C. fragilis*, from which it differs in its distinctly unequal-sided pinnae and raised veins, and especially by the termination of the veins; these run invariably to the

actual sinus of emarginations, whereas in *C. fragilis* they run out to the tip of the teeth. In *C. regia* (L.) Desv. also the veins run to marginal sinuses, but from this species *C. kansuana* is readily distinguished by its smaller size and less incised blades, and especially by its acroscopic basal pinnules, the pinnae being strongly inequilateral at base (the produced upper base truncate, the lower cuneate). *C. kansuana* finds a closer ally in *C. Mairei* Brause, from Yunnan, which has similarly unequal-sided pinnae with the veins running to emarginations, but that is a much larger plant, with stipe more than 20 cm. long and tripinnatifid blades.

Dryopteris (Eudryopteris) Giraldii (Christ) C. Chr., sp. nov.

Aspidium filixmas var. *Giraldii* Christ, Nuov. Giorn. Bot. Ital. n. s. **4**: 94. 1897.

Rhizome probably erect or oblique. Fronds suberect, up to 75 cm. long or more; stipe stramineous, up to 35 cm. long, rather freely but deciduously paleaceous, the scales thin, pale brown, narrowly lanceolate; blade broadly deltoid-ovate, about 40 cm. long and broad, bipinnate-pinnatifid, herbaceous, pale green, devoid of hairs, the rachis stramineous, glabrous, but more or less paleaceous by soft pale lanceolate-linear scales; pinnae about 10 pairs, alternate, the basal ones often a little shorter than the following, their lower side not or very slightly produced; largest pinnae about 20 cm. long, 6 cm. broad, petiolate (1 cm.), acuminate, unequal at base, the distal basal pinnule being somewhat elongate, the proximal one generally much shortened; pinnules 12–15 pairs, alternate, the larger ones short-petiolate, the upper sessile and decurrent (costae sometimes alate to the base), inequilateral at base, narrowly deltoid, acuminate, about 4 cm. long, 1 cm. broad or more, pinnatifid two-thirds or three-fourths the distance to the costa, or the larger ones of the lower pinnae near pinnate; segments close, oblique, oblong, ending in 4–6 unequal, sharp, often spinulose, falcate teeth; distal basal segment as a rule somewhat elongate, the proximal one oblique, often much shortened; veins pinnate in the lobes, the ultimate ones simple, terminating in a hydathode at the base of the teeth; sori borne on the middle of the anterior basal veinlets of the segments, solitary or the larger segments bearing 3–6; indusia reniform, about 1 mm. broad, persistent, glabrous, the margins slightly erose.

KANSU: Hsia Mo K'ou, near Lichen; alt. 2070 m.; common under trees; July 8, 1923; *R. C. Ching* 382.

SHEN-SI: Many collections, *Giraldi* (reported by Christ, loc. cit.); also *Purdom* 67.

SHAN-SI: Several localities, *Harry Smith* 5642, 6384, 6536, 7621.

SZE-CHUAN: *Harry Smith* 4704.

This species, which evidently is common in the mountains of Central China, is most distinct, but has been referred to various species. Numerous specimens collected in Shen-si Province by Giraldi, which are quite identical with those from Kansu and Shan-si Provinces, were regarded by Christ as a variety of *D. filixmas;* and I myself have referred with doubt certain material[2] from Shen-si to *D. marginata* (Wall.) Christ, and to the same species other specimens[3] from northern Sze-chuan which differ somewhat from *D. Giraldii*

[2] Bot. Gaz. **52**: 332. 1911.

[3] Med. Bot. Trädgård, Göteborg **1**: 61.

in their smaller sori and more acuminate segments, with shorter teeth, but are otherwise identical. From all the allies of *D. filixmas* with more divided blades (*D. marginata*, *D. fructuosa*, and others) *D. Giraldii* differs, however, very distinctly in its unequal-sided secondary pinnules. In this character it resembles *D. sparsa* (Ham.) Kuntze, and it is in my opinion a member of the small group of which that is the best known species. *D. sparsa* differs widely from *D. Giraldii* in its much thicker texture and in having the teeth not nearly so sharp.

To this group belong also *D. Sabaei* (Fr. & Sav.) C. Chr. and *D. subtripinnata* (Miq.) Kuntze, these, perhaps, forms of a single species which may include also *D. gymnophylla* (Baker) C. Chr.; and I think several Chinese specimens of *D. Giraldii* have actually been referred to *D. Sabaei*. That species differs in its smaller size and broad deltoid blades, with strongly basiscopic pinnae.

There remains yet to compare the new species with *D. laeta* (Komarov) C. Chr., which is unknown to me.

PROCEEDINGS OF THE ACADEMY AND AFFILIATED SOCIETIES

PHILOSOPHICAL SOCIETY

956TH MEETING

The 956th meeting was held at the Cosmos Club April 17, 1927.

Program: GREGORY BREIT: *Wave mechanics.*

957TH MEETING

The 957th meeting was held at the Cosmos Club April 30, 1927.

Program: HOWARD S. RAPPLEYE: *Some "fool proof" checks on computations.* A short discussion of various methods of checking certain types of calculations and their value in freeing the computation from blunders or mistakes of considerable size rather than checking absolutely the last figure of the result.

The idea was emphasized that a check computation which arrived at the final result by a route or method differing as widely as possible from that followed or used in the original calculation was most apt to render the computation free from "busts." Several examples of somewhat unusual checking methods were given.

A method of checking the computation of the observed seconds in observations taken with a direction theodolite was explained in detail as an example of the type of check which varies so widely from the original computation as to be a fair example of a "fool-proof" check.

P. HIDNERT: *The thermal expansion of graphite.* (Tech. Pap. Bur. Stand. **21**: 223–230. 1927.)

C. H. MEYERS and M. S. VÁN DUSEN: *The vapor pressure of liquid carbon dioxide.* The vapor pressure of carbon dioxide was observed from the triple point (−56.59°C.) to the critical point (+31.1°C.). The results are based on observations of three samples which were in contact only with glass and

mercury. Observations were made on five samples in metal containers but, because of unsatisfactory experimental conditions, the results obtained with these samples were given no weight in selecting the final values for the vapor pressure.

The material was prepared from pure sodium bicarbonate and pure sulphuric acid, and was purified by fractional sublimations and distillations.

Measurements of the triple point pressure (5.113 atmos.) were made, and the triple point temperature was calculated from an equation which represents the vapor pressure measurements.

Observations of the critical temperature (31.1°C.) and its corresponding pressure (72.95 atmos.) were also made.

A six constant equation was used to represent the results. It is believed that the values calculated from this equation are not in error by more than 1 part in 3000.

The results were compared with those of previous observers.

Tables were published which give the vapor pressure in atmospheres or millimeters of mercury for each degree Centigrade and in pounds per square inch for each degree Fahrenheit.

958TH MEETING

The 958th meeting was held at the Cosmos Club May 14, 1927.

Program: OSCAR S. ADAMS: *The readjustment of the western triangulation net.* During the past fifty years the first-order triangulation in the West has been gradually extended until now the total length of arcs is about twelve or thirteen thousand miles, or enough to reach half way around the earth at the equator. The earlier adjustments were made in separate sections as the work was finished and any loop closures that developed were adjusted into the last arc of the loop. To correct this obviously unjustifiable procedure, Major William Bowie, Chief of the Division of Geodesy of the U. S. Coast and Geodetic Survey, early in 1924 devised a method of adjusment by the use of junction points and intermediate sections of arcs so that these closures could be distributed throughout the whole network and no section would be required to absorb an undue amount of the closures. By the use of the Laplace azimuths in the adjustments of the sections, the resulting closures of circuits have been reduced considerably from what were found when no such conditions were introduced. In the total number of loops that were adjusted, the largest closure is 31 feet in 950 miles, which amounts to about ten paces in a distance equal to that from Washington to Kansas City. Only two loop closures were greater than one part in 200,000 and the mean of all the closures was about one part in 450,000. The closure around the entire outer boundary is 33 feet, in a distance of 5300 miles, or approximately one part in 842,000.

N. H. HECK: *International attack on the earthquake problem.* From time to time there have been discussions on seismology before the Society, but the international background has never been presented.

The important contribution of Europe was discussed at considerable length.

Great Britain was the first to establish throughout the earth seismological stations with photographically-recording instruments and was among the first to study wave transmission and identify the various phases. Accordingly, this country is responsible for the long series of tables of epicenters of earthquakes from 1899 to the present, though since 1917 the International Seismological Summary has been prepared in Great Britain under the auspices of the International Geodetic and Geophysical Union.

The Germans have used visible-recording seismographs of great mass to eliminate the effect of friction. Important contributions from this country include mathematical studies and identification of phases resulting from reflection and refraction, also identification of surfaces of discontinuity and study of depth of focus. Preparation of travel-time curves and tables has been an important contribution.

The conception of a 60 km. layer beneath the continents is due to the work of the two Mohorovicics in Jugoslavia.

A very important Russian contribution was the Galitzin instrument, which in spite of certain difficulties is probably one of the best and most sensitive seismographs in existence today. Galitzin himself contributed an important treatise on transmission of elastic waves and the theory of the seismograph. French, Spanish and Italian contributions were discussed.

Accordingly, the European attack on the earthquake problem is chiefly from the mathematical and physical viewpoint. The study has been aided by the relative infrequency of earthquakes, but also handicapped by the comparative lack of data recorded as compared to other countries.

Coming to Asia, the Dutch East Indies have contributed by showing that submarine geology can be studied by means of seismograph investigations.

To supplement existing impressions of the great destruction in Japan accompanying the earthquake of September 1, 1923, a number of special instances were given as to the disturbances of activities of all sorts. Instances included complete destruction of the Hydrographic Office, the Land Office, partial destruction of the Imperial University at Tokyo, changes in Sagami Bay resulting from the raised shore and effect of land slides. A number of lantern slides depicting earth damage were shown.

The Japanese are placing considerable confidence in scientific investigation. They are replacing their undamped with damped instruments and have Galitzin instruments in Tokyo. They have a special apparatus for recording very long waves.

The situation in the rest of Asia, in Africa, and the American continents south of the United States was discussed, as well as Australia and the South Pacific.

In Canada, Dr. Klotz contributed important travel-time tables and an important investigation is going on at present.

In the United States, an early start was made with an American first suggesting the use of damping. However, the work failed to catch the imagination of the people and only moderate progress, scarcely worthy of this country, has been made. Recently the joint investigations in California by the Carnegie Institution of Washington, government bureaus, universities, and business institutions; the reorganization of the Jesuit Seismological Association and the installation of new instruments, adoption of improved methods and preparation of travel-time tables; the progress of the Coast and Geodetic Survey, which includes improved instruments in Porto Rico, Hawaii, and Alaska, as well as in certain places in the United States, all point to renewed activity in the subject which is likely to lead to important results. The Coast and Geodetic Survey is also preparing a quarterly report giving all earthquake shocks felt or recorded in the United States.

To a certain extent this growth may be trusted to continue, and the suggestion is made that physicists will find in this field ample opportunities for investigation and worth-while work which is contributing to the interests of humanity.

959TH MEETING

The 959th meeting was held at the Cosmos Club, May 28, 1927.

Program: C. S. CRAGOE: *The thermal properties of petroleum oils.*

G. R. WAITE and H. U. SVERDRUP: *Preliminary note on the electromotive forces possibly produced by the earth's rotating magnetic field, and on the observed diurnal variation of the atmospheric potential gradient.* The first part of the paper contains a formal computation of the electromotive forces which would be induced, upon certain hypotheses, at the magnetic poles of the earth on account of the rotation of its magnetic field. Supposing that these electromotive forces act upon charged particles entering the upper atmosphere and coming from the sun, it is possible to compute an incoming "current." The principal assumptions are: (1) That charged particles of a given sign are accelerated towards the earth when the electromotive forces have certain directions referred to the relative position of sun and earth, and (2) that the effect is of equal magnitude along the three rectangular axes. The "current" thus computed shows a diurnal variation and annual variations of phase-angle and of amplitude which are in remarkable agreement with corresponding variations of the atmospheric potential-gradient as actually determined from observations made at sea by the *Carnegie*, in the Arctic by the *Maude* expenditions, and at certain land stations. This agreement appears to be too good to be accidental; it is difficult, however, to develop a physical basis to explain, entirely satisfactorily, more than a quantitative relationship between the two phenomena.

H. E. MERWIN, *Recording Secretary.*

SCIENTIFIC NOTES AND NEWS

Prof. H. N. RUSSELL of Princeton University gave a talk at the Bureau of Standards on November 4, on *The structure of the elements of the iron group.*

J. W. FRENCH, Technical Director of Barr & Stroud, Ltd., manufacturers of military optical instruments, Glasgow, lectured on *Optical glass* at the Bureau of Standards on October 15.

The grasses collected on the South Atlantic Expedition, 1923–1926, of the Cleveland Museum of Natural History, exploring schooner BLOSSOM under the command of George Finlay Simmons, have been sent to the Grass Herbarium for study. Except for a few from Senegal the grasses were all collected on islands on both sides of the Atlantic. While the collection is not large there are many species not before recorded from Ascension, St. Helena, South Trinidad, Fernando Naronha, and the Cape Verde group. A complete set is deposited in the Grass Herbarium.

The American Ornithologists' Union held its annual meeting at the National Museum November 14 to 17. The officers for the year 1926–1927 were: Alexander Wetmore, Assistant Secretary of the Smithsonian Institution in charge of the National Museum, President; T. S. Palmer and W. L. McAtee, of the Biological Survey, Secretary and Treasurer. An account of the meeting will be published in a later number of the JOURNAL.